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Two new species of Collembola (Arthropoda, Hexapoda) from Cova Urbana, a cave under a city

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Abstract

The Collembola fauna of the Cova Urbana located under the city of Tarragona (Spain) is studied, and the climatic characteristics of the cave, its partial geomorphology and its planimetry are presented. For the first time in this cave, some specimens of Collembola have been captured and studied, and two new species for science belonging to the genera *Coecobrya* and *Pygmarrhopalites* are described and illustrated. In addition, a specimen of the genus *Arrhopalites* probably belonging to another new species has been studied, but it could not be described because only one specimen was available. The presence of so few specimens and only four species is attributed to the absence of organic matter from percolation and detritus (oligotrophic cave).

Keywords

Arrhopalitidae, cave fauna, Entomobryidae, new species, troglobionts, urban cave

Introduction

The "Cova Urbana de Tarragona" (Fig. 1) is a cavity located in the basement of the city of Tarragona. It was discovered accidentally, when laying the foundations of a new building in 1996, although there was already news of its existence in 'Tarragona

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Figure 1. One of the cave galleries of Cova Urbana, showing its character flooded by the water table. Author: Víctor Ferrer Rico, a professional photographer specialized in caves.

Monumental', a book from 1849 (Albiñana et al. 1849), when investigating a Roman water conduction gallery. An opening in this gallery leads to a natural cavity with wells, lakes, large rooms, and a highly developed underwater network, not fully explored. The cavity can be visited, with a prior request to the "Societat d'Investigacions Espeleològiques de Tarragona (SIET) (Arnabat Castilla 1998; Ferrer 2014).

Methods

Characteristics of studied cave

This cavity, excavated in a small core of dolomites from the Jurassic period, has developed through a stratification joint, expanded by the corrosion of water from the phreatic level marked by the base level of the Mediterranean. There are also some samples of water circulation under hydrostatic pressure. Subsequent graviclastic processes have created rooms of notable volume, with the consequent chaos of resulting blocks. The chemolithogenic process is very small, taking into account the development of the cavity: it is limited to the base of the entrance shafts and first rooms. The enormous volume of water in the cavity is of phreatic origin and the analyzes carried out by the "Societat d'Investigacions Espeleológiques" show a very

low level of chlorides and sodium, so it is ruled out that there may be contact or leaks of seawater, given its proximity (Llopis Lladó 1970; IGME 1986). The karstifiable dolomite massif, where the cavity is developed, is isolated by alluvial terrain and Quaternary foothill areas and without contact with other nearby massifs with the same characteristics (Musara, Montsant) (ICGC 2023). Towards the east, there is an outcrop of Miocene reef calcarenites, weakly karstifiable, in contact with the dolomites of the cavity. The absence of forms of absorption from the outside may suggest the possibility that it is a cavity of hypogenic origin (Miñarro et al. 2021). A detailed geomorphological study of the cavity would be necessary to accurately determine this provenance.

The climatic conditions of the cavity are exceptional, with a very high-temperature range along the cave (between 20.1 °C and 21.9 °C.) and a relative humidity that is also very high (HR 97.9), a logical consequence of the evaporation of water from the cavity. The concentration of ambient oxygen varies according to the area: from 18.7% to 20.5%, although in one of the Roman galleries half-clogged by debris, 17.2% was recorded. The measurements were carried out with a Hibok C-315 digital thermo-hygrometer and a Hibok P2-250 digital oximeter.

Biocenosis and sampling

A priori, the biological condition of this cavity could be described as almost azoic in terms of troglobitic fauna, considering the faunal richness of relatively nearby cavities. The Cova Urbana is a very mineral cavity, that is, being without contact with the outside, there is no organic, vegetal, or animal matter inside, which could facilitate the formation of a trophic chain: the scarcity of fauna may be motivated due by the poor ecological conditions (limited availability of food) of this underground habitat and the geological isolation of the cavity (Racovitza 2004; Sendra 2023). Despite the numerous visits and the pitfall and aquatic traps, only a few terrestrial isopods (possibly *Catalauniscus* sp.) located at the base of the entrance wells; a specimen of 'very small shrimp', possibly an amphipod, accidentally captured when taking one of the water samples for analysis (J.M. Plana, personal communication). If we count the trogloxene and troglophile fauna, the relationship becomes a little more extensive, although their habitat is the Roman galleries and entrance wells, which maintain a certain communication with the outside environment: spiders from various families (some under study), some Blattidae, very abundant in the upper levels, Diptera (*Limonia* sp.) and a Myriapoda, possibly *Lithobius* sp. that could not be captured.

Springtails are the most representative troglobitic fauna of the cavity, and for this reason, sampling has focused on their capture. They have only been found –and after many attempts– in the Maginet Room (Fig. 2), near the main siphon of the cavity, in a piece of wood abandoned by the cave conditioning works. The subsequent placement of attraction baits at this point facilitated the collection of springtails, but only *Folsomia candida* Willem, 1902 was captured.

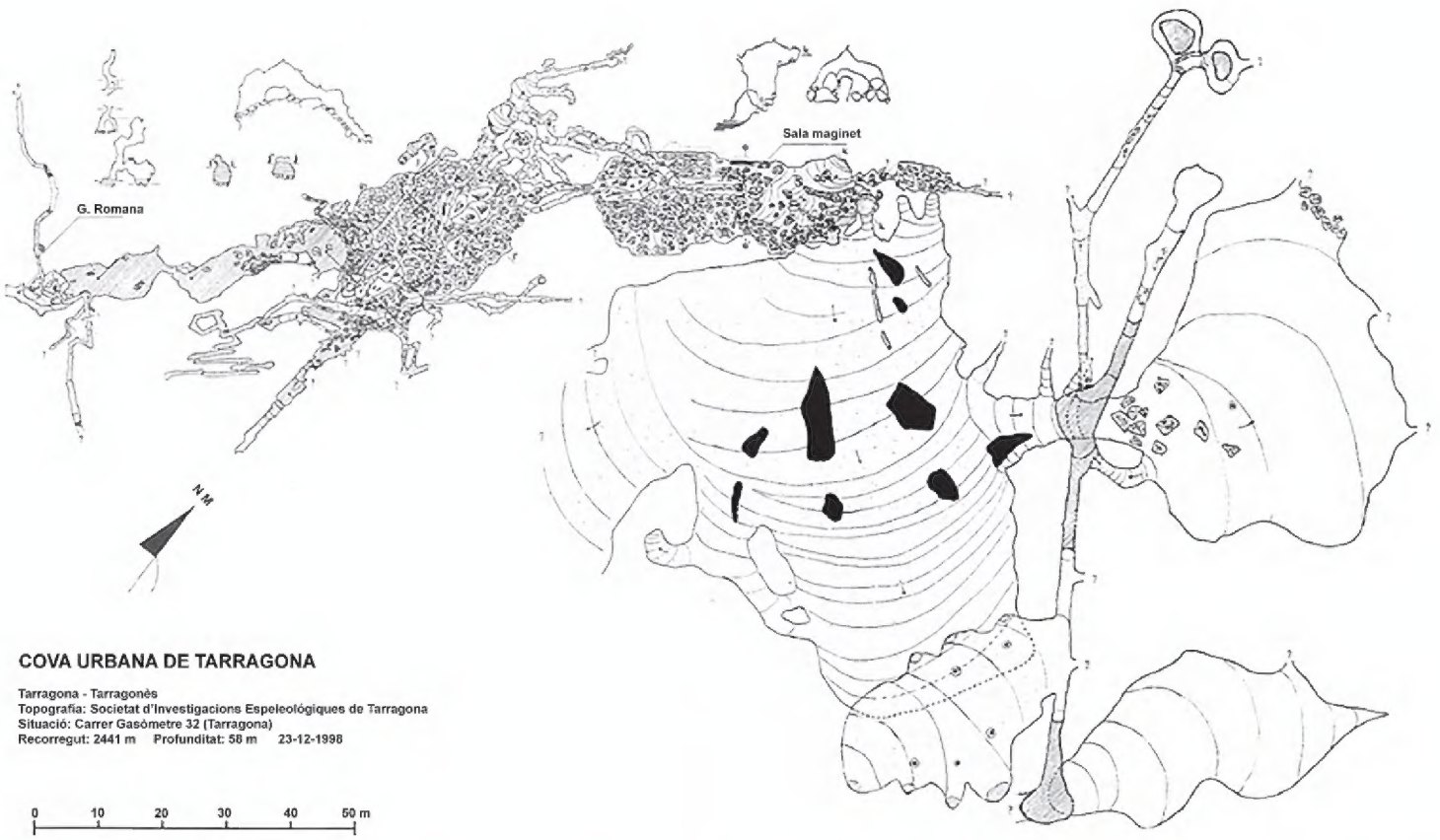
Sala maginet
G. Romana
N M
COVA URBANA DE TARRAGONA
Tarragona - Tarragonès
Topografia: Societat d'Investigacions Espeleológiques de Tarragona
Situació: Carrer Gasómetre 32 (Tarragona)
Recorregut: 2441 m Profunditat: 58 m 23-12-1998
0 10 20 30 40 50 m

Figure 2. Original diagram of the topography of Cova Urbana elaborated by the Societat d'Investigacions Espeleològiques de Tarragona team.

Material processing

After the preliminary sorting to separate the Neelipleona and Symphypleona from other Collembola, some representative specimens of each species were selected and mounted in Hoyer's medium for observation under a microscope, and some specimens were cleared in Nesbitt's fluid. The remaining samples were stored in 70% ethyl alcohol. The slides were observed under two microscopes: an Olympus BX51-TF (Olympus Group, Tokyo, Japan) with multiple viewing and phase contrast and a Zeiss model Axio Imager.A1 with differential interference contrast (DIC). For measurements, a U-DA drawing attachment UIS (Universal Infinity System) and a scale calibrated with a slide by Graticules Ltd., Cambridge, UK (1 mm divided in 100 parts) were used. For SEM (Scanning Electron Microscopy) the specimens were dehydrated using a series of ethyl alcohol followed by critical-point drying in CO_2, then mounted on aluminum SEM stubs, and coated in an Argon atmosphere with 16 nm gold in a sputter-coater Emitech Ltd., Strovolos, Chipre, model K550. SEM observations were made with a FE-SEM Zeiss model Sigma 300 VP (Zeiss, Oberkochen, Germany).

Nomenclature

The terminology for *Pygmarrhopalites* Vargovitsh, 2009 used in descriptions follows Fjellberg (1984) for the outer maxillary palp; Christiansen and Bellinger (1996) for Ant III sensory organ; Bretfeld (1999) for Abd VI; Christiansen (1966) and Christiansen

and Bellinger (1998) for empodium; and Vargovitsh (2009, 2017), for head, body, and legs. The material has been deposited at MZNA—Museum of Zoology at the University of Navarra (Pamplona, Spain). The terminology for *Coecobrya* follows Jordana and Baquero (2005) and Zhang and Deharveng (2015) for dorsal chaetotaxy.

Abbreviations used in the description

Abd	abdomen or abdominal segment I–VI
al	anterolateral s-chaeta
as	anterosubmedial s-chaeta
Ant	antennal or antenna/ae
a.s.l.	above sea level
Mc	macrochaeta/ae
mes	mesochaeta
mic	microchaeta
ms	microsensillum/a
PAO	postantennal organ
psp	pseudopore
Th	thorax, or thoracic segments

Institutions

MZNA	Museum of Zoology at the University of Navarra, Pamplona, Spain

Results

Faunistic study

Throughout three samplings, four species belonging to the Collembola group have been found, and one mite specimen (possibly due to accidental presence). Regarding the Collembola, in addition to the two species described, a single specimen of *Arrhopalites* sp., and 17 specimens of *Folsomia candida*, a cosmopolitan species present in many biotopes in addition to in caves, where it sometimes causes problems due to transporting fungi from the outside that alter the ecosystem were also collected.

Taxonomic part

Class Collembola Lubbock, 1873
Order Entomobryomorpha Börner, 1913
Family Entomobryidae Schäffer, 1896 sensu Godeiro et al. 2023
Subfamily Entomobryinae Schäffer, 1896 sensu Godeiro et al. 2023
Genus *Coecobrya* Yosii, 1956

Coecobrya urbana **Jordana & Baquero, sp. nov.**
https://zoobank.org/18825AE8-013D-42A0-9A18-30994FDAF0FA
Figs 3–8

Type material. ***Holotype*** • female on slide, Spain: Tarragona city, Tarragona province, Cova Urbana, geographic coordinates 41.114193, 1.248222, 15 m a.s.l. (the entrance is in an urban area), 6/vii/2022, dark zone of the cave, by aspirator (MZNA code 782957). ***Paratypes*** • same data as holotype, three females on two slides (MZNA codes 782958, 782972 to 782973), 10 in ethyl alcohol (MZNA codes 782961 to 782970) and one mounted on stub for SEM observation (MZNA code 782971) • 29/vii/2022, two females on slide (MZNA codes 782972 to 782973), and two specimens in ethyl alcohol (code samples 782987 to 783988) • 1/vii/2023, 10 specimens in ethyl alcohol (code samples 782975 to 783985) and one mounted on stub for SEM observation (MZNA code 782971). All Floren Fadrique leg (BIOSP, Associació Catalana de Biospeleologia). Specimens deposited in MZNA.

Description. ***Habitus*** as in Fig. 3. Body length (without antennae) up to 1.7 mm (holotype 1.6 mm). No scales. Eyes absent. Color whitish in alcohol, without any pigment. Antennae 1.41–1.85 times the length of the head (n = 4; lower proportion in smaller specimens). Abd IV 3.4 times as long as Abd III.

Antennae (Figs 4, 5). Antennal segments not subdivided nor annulated. Ant I dorsally with two Mc type one (capitate), numerous Mc type two (acuminate) with different sizes (Christiansen 1958), and three small mic at basis, forming a triangle, with the distal one bigger; ventrally with 9–10 basal smooth spiny mic of various sizes; one distal pseudopore. Ant II dorsally without paddle-like chaetae in its distal part, with small sensilla; two distal pseudopores. Ant III sensory organ as usual, with five sensillae and the special ones swollen. Ant IV 1.55–1.83 times longer than Ant II or Ant III, not subdivided, without apical bulb. Subapical organite slightly knobbed, with a basal accessory special small mic.

Head. Clypeal and labral areas in Fig. 6A; prelabral and labral chaetae (4/5, 5, 4) all smooth, central chaetae of row a thicker, and external on small papillae. Maxillary outer lobe with one apical and one basal chaeta, and three sublobal hairs (Fig. 6B). Papillae E of labrum in Fig. 6C. Chaetae of labial basis all smooth (-mrel$_1$l$_2$) similar in length except for 'r' short. One or two special 'x' chaetae. On each side of linea ventralis, 5–6 smooth and 1–2 ciliate chaetae (Fig. 6D).

Legs. Legs devoid of scales, covered with ordinary ciliated chaetae of various lengths, mic not seen. Coxa of leg I with one proximal psp and two chaetae posteriorly; coxa of leg II with eight chaetae in anterior row, two chaetae in posterior row and one proximal psp; coxa of leg III without proximal psp. Trochanteral organ with 15 smooth, straight, unequal spine-like chaetae (Fig. 7A). Tenent hair spatulated (22–30 μm). Tibiotarsi I–III with a single row, interior, of appressed chaetae, the most distal on tibiotarsus III smooth. Claw slender (Fig. 7B–D); claw I and II subequal, claw III slightly longer. All claws with a pair of basal inner teeth at approx. 35–40% and two unpaired inner teeth at 55% and 80–90% of inner edge from basis respectively. Empodium approx.

Figure 3. *Coecobrya urbana* sp. nov. habitus at SEM. Scale bar: 0.1 mm.

0.8 times as long as inner edge of claw, slightly swollen baso-internally, truncated apically, devoid of inner tooth, with a big outer tooth at 1/2 of its length.

Ventral tube (Fig. 7E). Anterior basal with 4 + 4 ciliated Mc; anterior distal flaps with 7 + 7 smooth chaetae; posteriorly with eight smooth chaetae, two of them as mic.

Furcal complex. Tenaculum with four large teeth and one ciliated chaeta. Manubrium covered with ciliated chaetae, and seven smooth chaetae on two rows on posterior side. Manubrial plate with two pseudopores and two ciliate chaetae, one each side. Dens without spines, annulated and covered with ciliated chaetae on both sides, and 2 + 2 basal smooth posterior chaetae. Distal smooth part of dens similar in length to mucro. Mucro falcate, basal spine long, nearly reaching the tip of the mucronal tooth (Fig. 7F).

Dorsal chaetotaxy (Fig. 8A, B). Head: dorsal cephalic chaetotaxy with four antennal (An_{1-3}, An_{3a1}), four anterior (A_0, A_{2-3}, A_5), four median (M_0, M_{1-2}, M_4) and seven sutural (S_0, S_{1-5}, S_{4i}) Mc. Th II with three (m_{1-2}, m_{2i}) medio-medial (area T1) (Jordana and Baquero 2005), three (a_5, m_4, m_{4p}) medio-sublateral (T_2) and 15–18 posterior Mc, 1 + 1 ms and 2 + 2 sensillae laterally. Abd II without Mc above internal bothriotrichum (area A1), three (m_3, m_{3e} and m_{3ea}) central (A2) and one (m_5) lateral Mc. Abd III without Mc on areas A3 and A4, only one (m_3) on area A5, and three (a_7, pm_6 and p_6) lateral Mc. Bothriotrichum not surrounded by modified chaetae. Abd IV with four central Mc (A_3, A_6, and B_{4-5}), four (E_{2-4}, D_3) lateral Mc and about nine long sensilla. Abd V with five Mc, and 3 + 3 sens. The S-chaetae formula is the usual for the family.

Ecology. The specimens were captured in the dark area of the cave (Sala Maginet), in the deep and isothermal area of the cavity, very close to the aerial end of the cave (from here, the route is underwater), on wood with fungus. After placing a cheese bait during 15 days on that same wood, only specimens of the *Folsomia candida* species were captured.

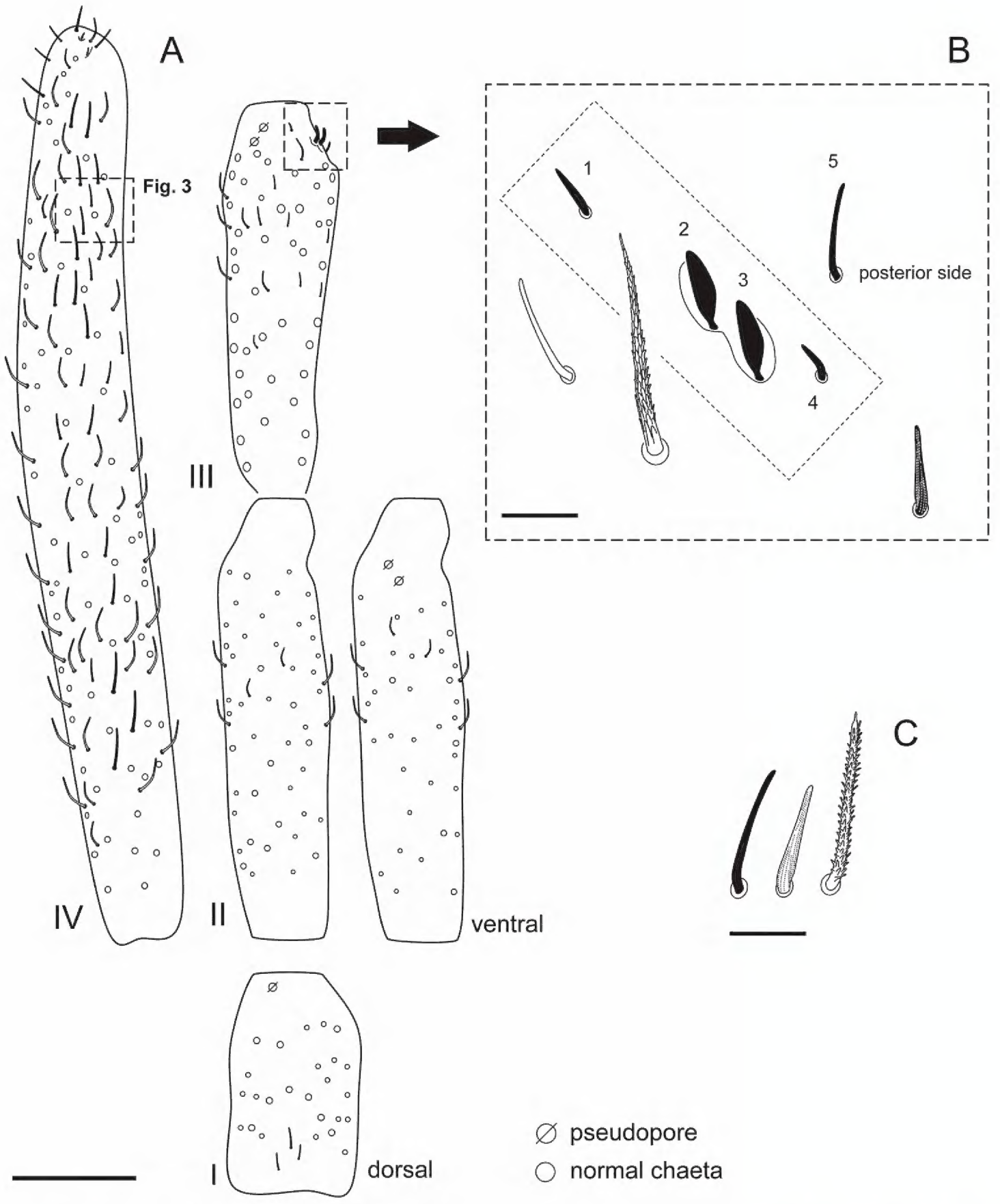

Figure 4. *Coecobrya urbana* sp. nov. **A** antennal segments I–IV (dorsal view except for Ant II, both) **B** detail of the Ant III sensory organ, and **C** the three types of sensilla on Ant IV. Scale bars: 0.05 mm (**A**); 0.005 mm (**B–C**).

Etymology. The new species is named after the name of the cavity where it was found, Cova Urbana, which in turn is so named because its entrance is in the heart of a city.

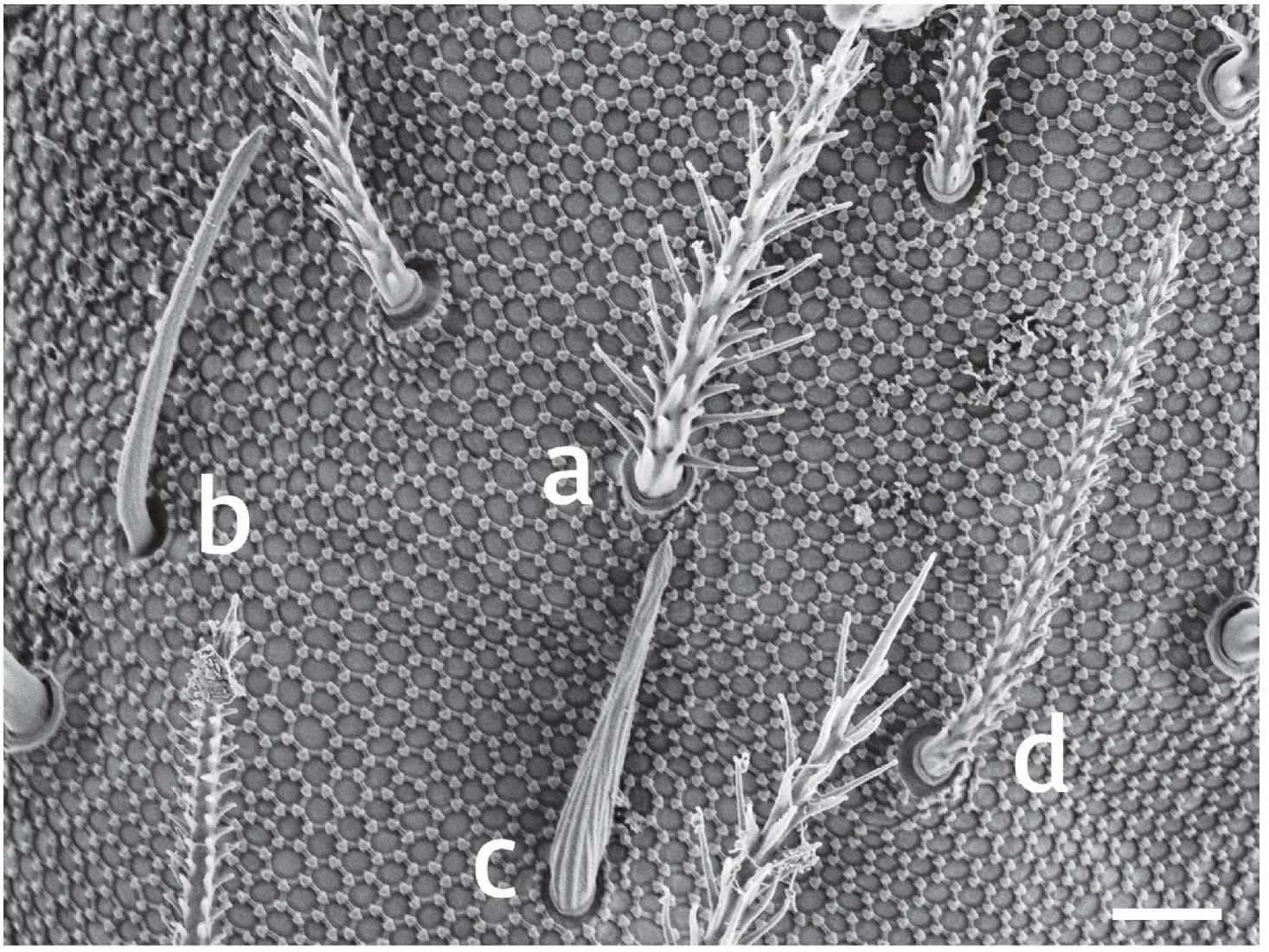

Figure 5. *Coecobrya urbana* sp. nov.: antenna, detail of Ant IV and different types of Mc (**a**) and sensilla (**b–d**). Scale bar: 0.002 mm.

Remarks. The new species differs morphologically from other known *Coecobrya* species by presenting four internal teeth of claw. To the best of our knowledge, *Coecobrya montana* (Imms, 1912) *sensu* Zhang, Deharveng & Chen, 2009 from India, *C. submontana* Stach, 1960 from Afghanistan, *C. troglobia* Jantarit & Nilsai, 2021 (in Nilsai et al. 2021) from Thailand and *C. decemsetosa* Jordana & Baquero, 2023 (in Baquero et al. 2023) from Portugal are the only four described species of *Coecobrya* with four teeth on the internal claw. Unfortunately, the chaetotaxy of *C. montana* and *C. submontana* are unknown (the type material was observed by the authors, and the conservation of the specimens made no possible to observe the chaetotaxy), but have small differences with *C. decemsetosa* and the new species described here in the morphology of the claw, a character used traditionally for differentiate the species. In addition, *C. decemsetosa* poses large differences in number of Mc on tergite from Th II–Abd V too. *C. submontana*, which has been studied after requesting some specimens deposited in Stach's collection of PAN (Polska Akademia Nauk, Warszawa, Poland), from a cave near Kabul, has a short basal spine on the mucro, and the dorsal tooth of the claw in an intermediate position between the base and the paired teeth of the inner edge. *Coecobrya troglobia* can be differentiated from the new species because it has longer antennae

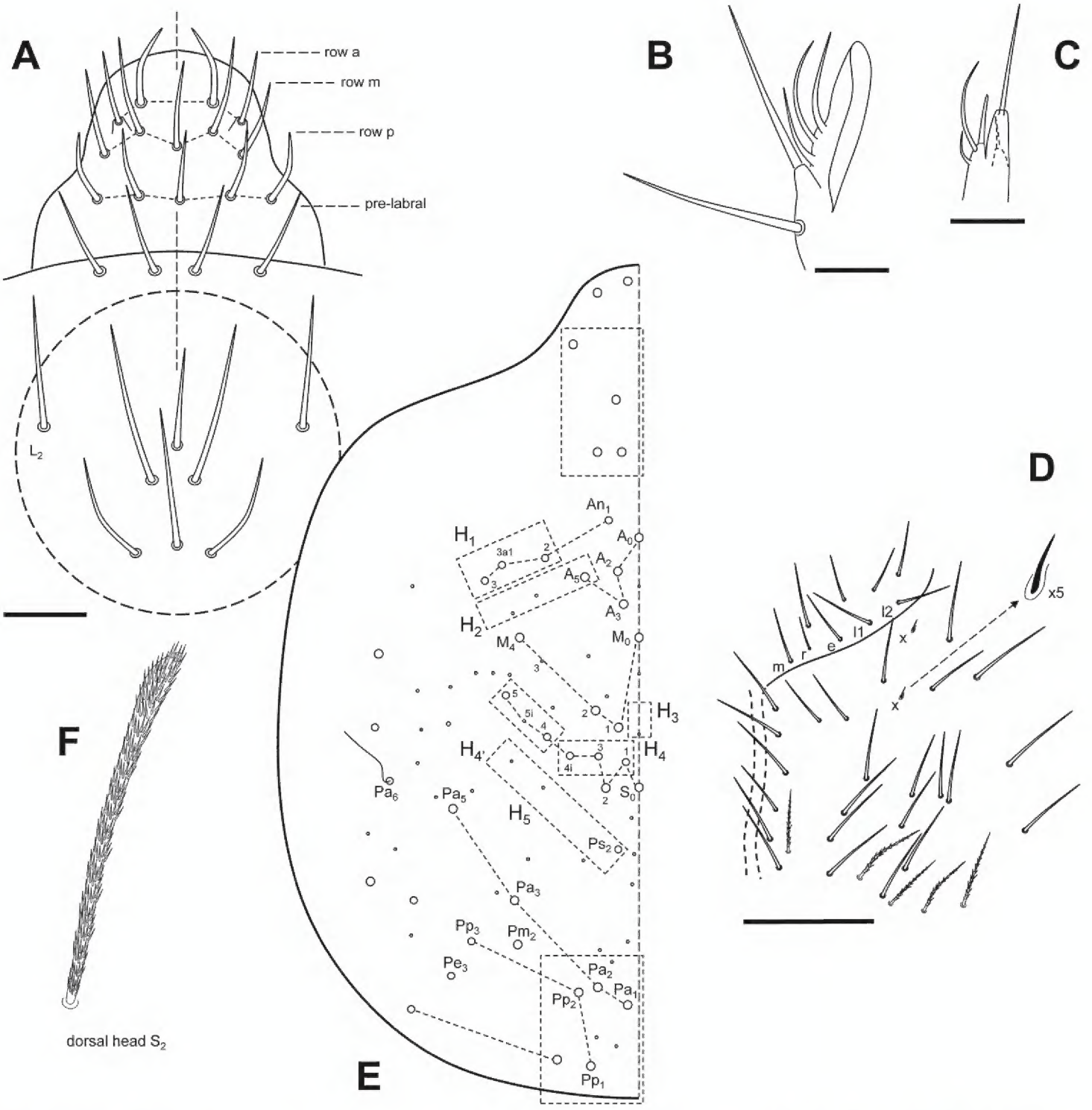

Figure 6. *Coecobrya urbana* sp. nov. **A** clypeal, prelabral and labral areas **B** maxillary outer lobe **C** papilla E of labrum **D** labial basis **E** head chaetotaxy. Scale bars: 0.02 mm (**A–C**); 0.075 mm (**D**).

(4–6.8 times the length of the head), the paired teeth on inner claw closer from the basis (30%), the external empodium serrated at its posterior half, only two Mc on dorsal Abd II, five central Mc (each side) on Abd IV and manubrium without smooth Mc.

Order Symphypleona Börner, 1901 sensu Bretfeld 1986
Suborder Appendiciphora Bretfeld, 1986
Superfamily Katiannoidea Bretfeld, 1994
Family Arrhopalitidae Stach, 1956
Genus *Pymarrhopalites* Vargovitsh, 2009

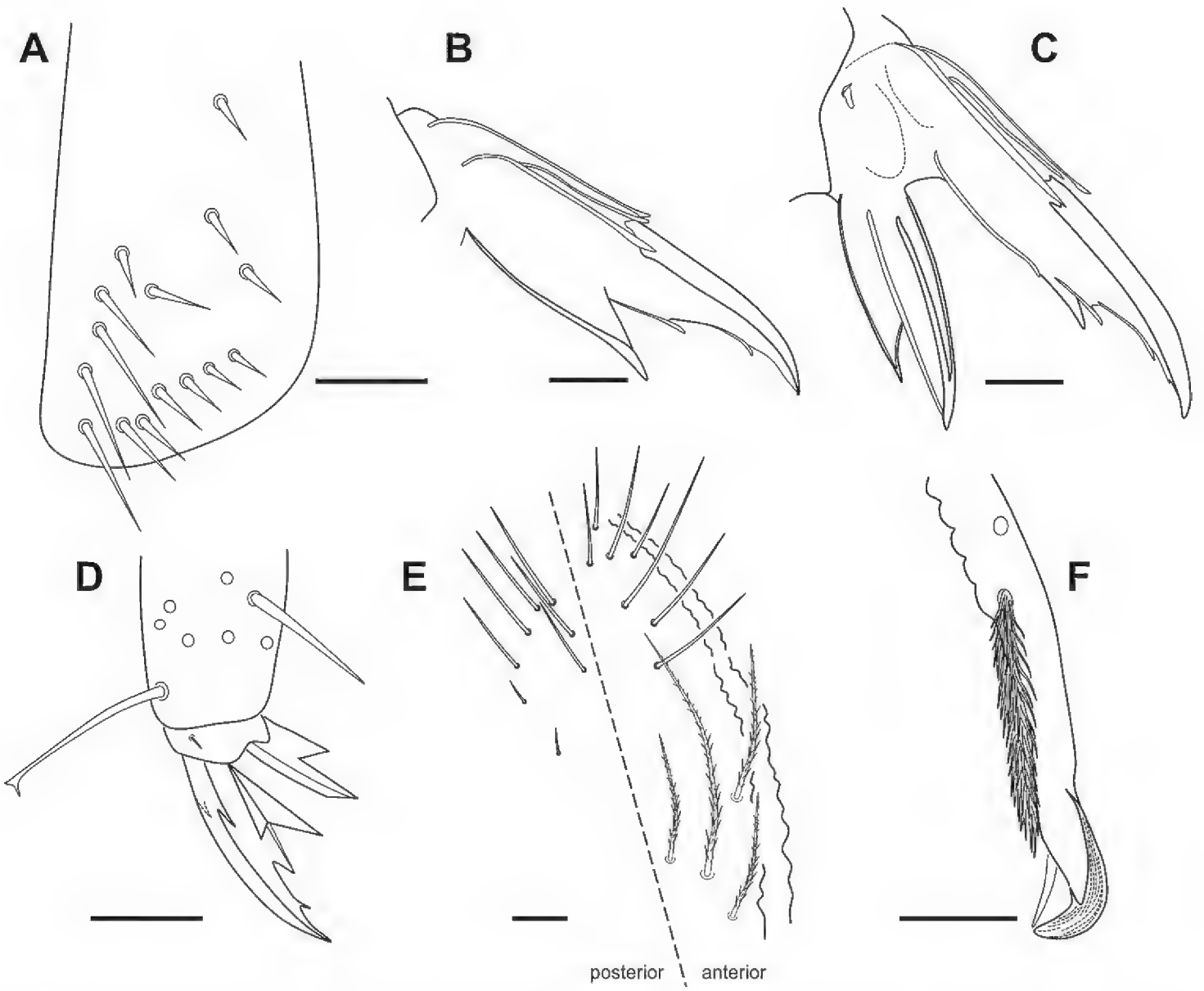

Figure 7. *Coecobrya urbana* sp. nov. **A** trochanteral organ **B** claw 1 **C, D** claw 3; **E** ventral tube **F** tip of dentes and mucro. Scale bars: 0.02 mm (**A, D, E**); 0.005 mm (**B–C**); 0.01 mm) (**F**).

Pygmarrhopalites sietae **Baquero & Jordana, sp. nov.**
https://zoobank.org/43E780DE-E64A-43B6-A2DD-B8BE6FACEC8D
Figs 9–14

Type material. ***Holotype*** • female on slide, Spain: Tarragona city, Tarragona province, Cova Urbana, geographic coordinates 41.114193, 1.248222, 15 m a.s.l. (the entrance is in an urban area), 6/vii/2022, dark zone of the cave, by aspirator (MZNA code 782954). ***Paratypes*** • same data as holotype, three specimens on slide (MZNA codes 782955 and 782986), and one mounted on stub for SEM observation (MZNA code 782953). All Floren Fadrique leg (BIOSP, Associació Catalana de Biospeleologia). Specimens deposited in MZNA.

Description. Female. ***Body*** not pigmented; length (holotype): head, 0.23 mm; body 0.62 mm.

Head. Eyes 1 + 1, unpigmented. Clypeal area, row a: 2 + 2 and an axial chaeta; row b: 2 + 2; row c: 2 + 2; row d: 4 + 4; row e: 5 + 5; row f: 4 + 4. Inter-antennal area, row α: 2 + 2;

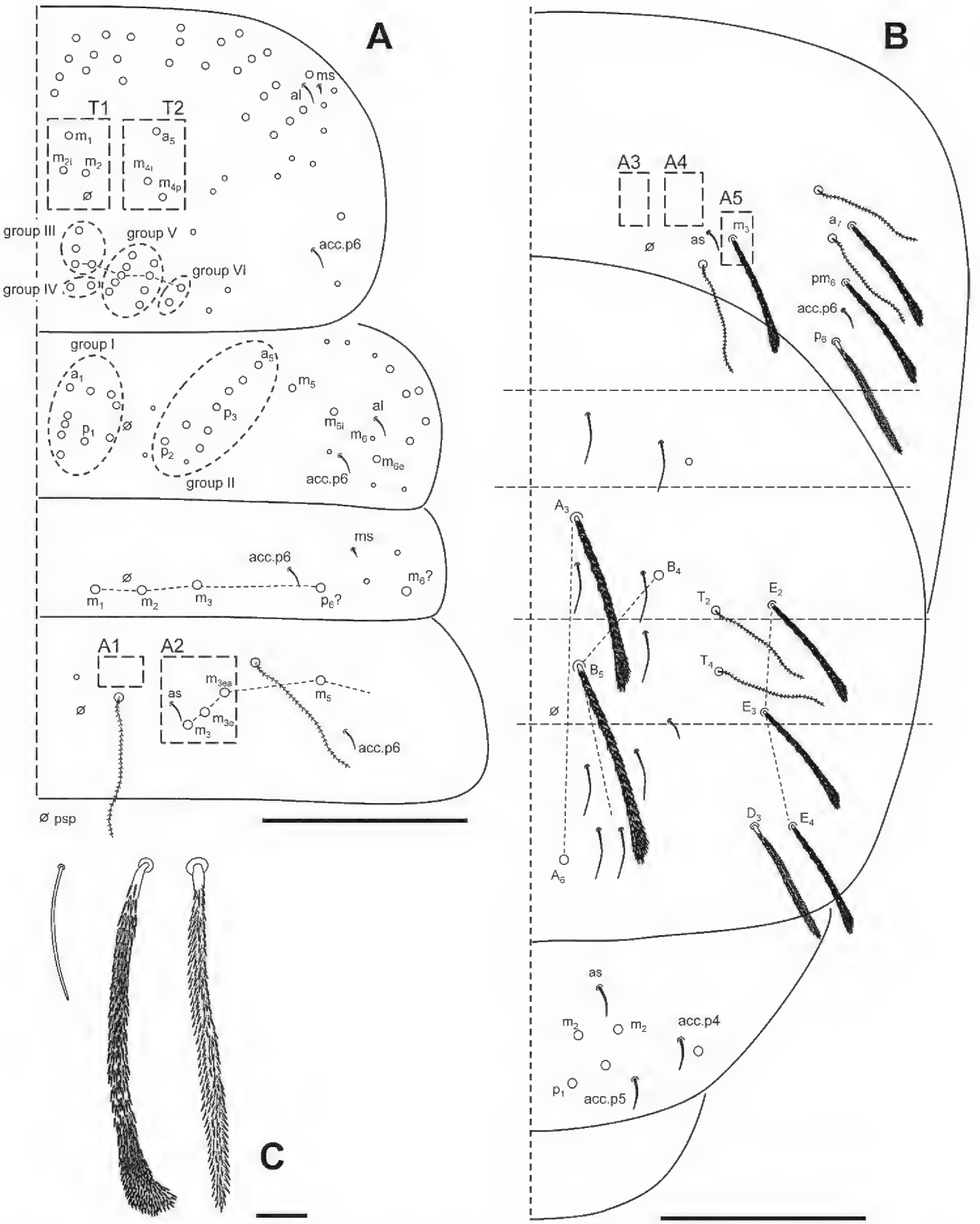

Figure 8. *Coecobrya urbana* sp. nov. **A** Th II–Abd II **B** Abd III–VI **C** detail of two Mc and a long sensilla of Abd IV. Scale bar: 0.05 mm (**A–B**); 0.01 mm (**C**).

row β: 1 + 1 and an axial chaeta; rows A and C: 2 + 2 and an axial chaeta; row B: 1 + 1 and an axial chaeta; row D: 2 + 2 chaeta. Lateral chaetae of rows C and D are not spine-like (Fig. 9A). Chaetotaxy of the mouth region. Labrum: pre-labral/labral chaetotaxy: 6/554. 2 + 2 chaetae near the ventral groove. Maxilla: apical chaeta of the maxillary outer lobe with a short and thin subparallel branch at the base; sublobal plate with three sublobal hairs.

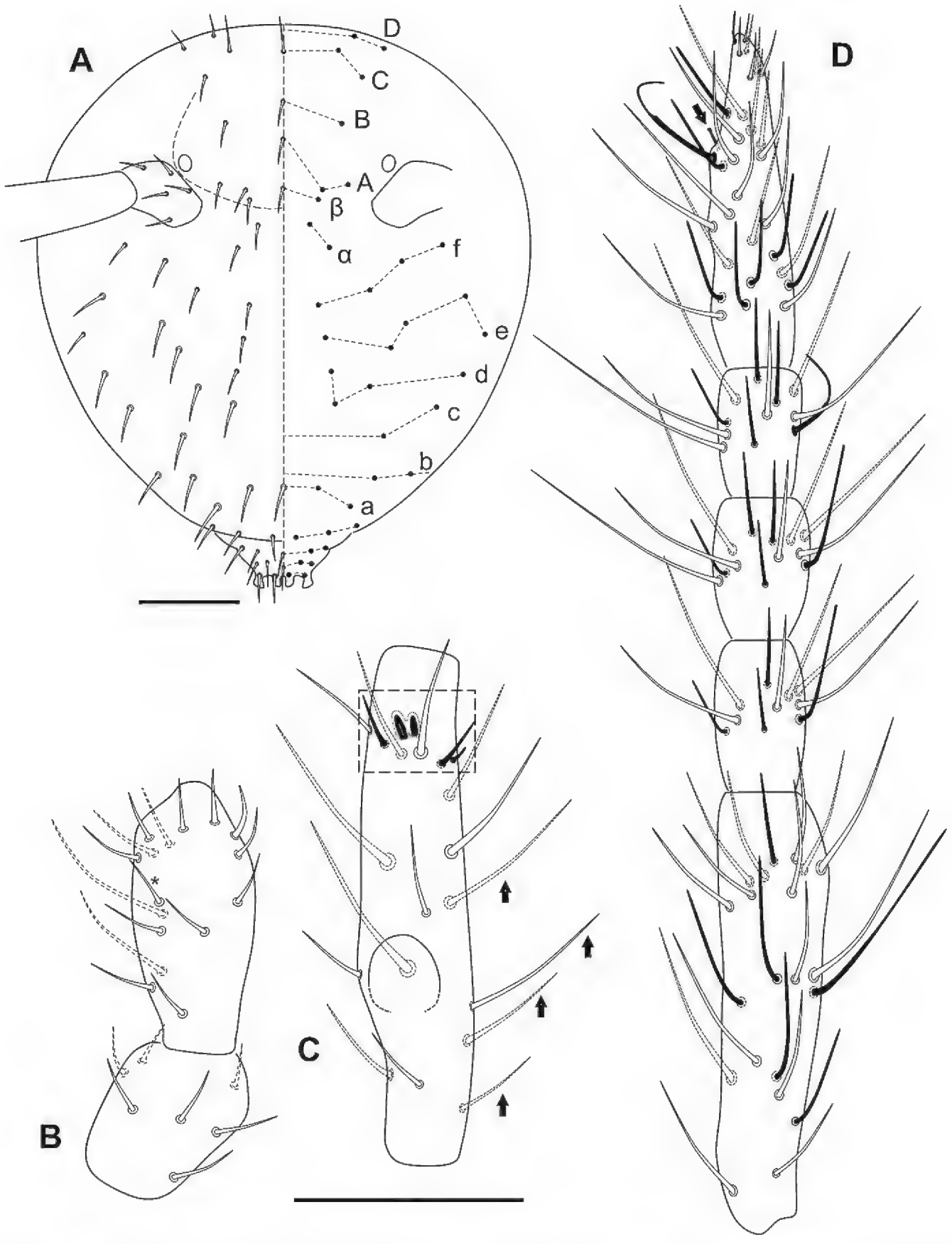

Figure 9. *Pygmarrhopalites sietae* sp. nov. **A** head chaetotaxy **B** Ant I–II (* means that this chaeta has been observed only in one specimen) **C** Ant III (the arrows point to chaetae that are noticeably thinner than the others and the sensory organ are included in a rectangle with the chaetae in black) Ant IV (the arrow points to the knobbed subapical organite). Scale bar: 0.05 mm.

Antenna (Fig. 9B–D): I/II/III/IV, 0.030/0.058/0.106/0.090-0.032-0.32-0.030-0.070; shorter than the body (ratio 0.72) and ratio Ant/head as 1.95; basal subsegment of Ant IV 0.84 times longer than Ant III. Ant I with seven chaetae, any as mic. Ant II

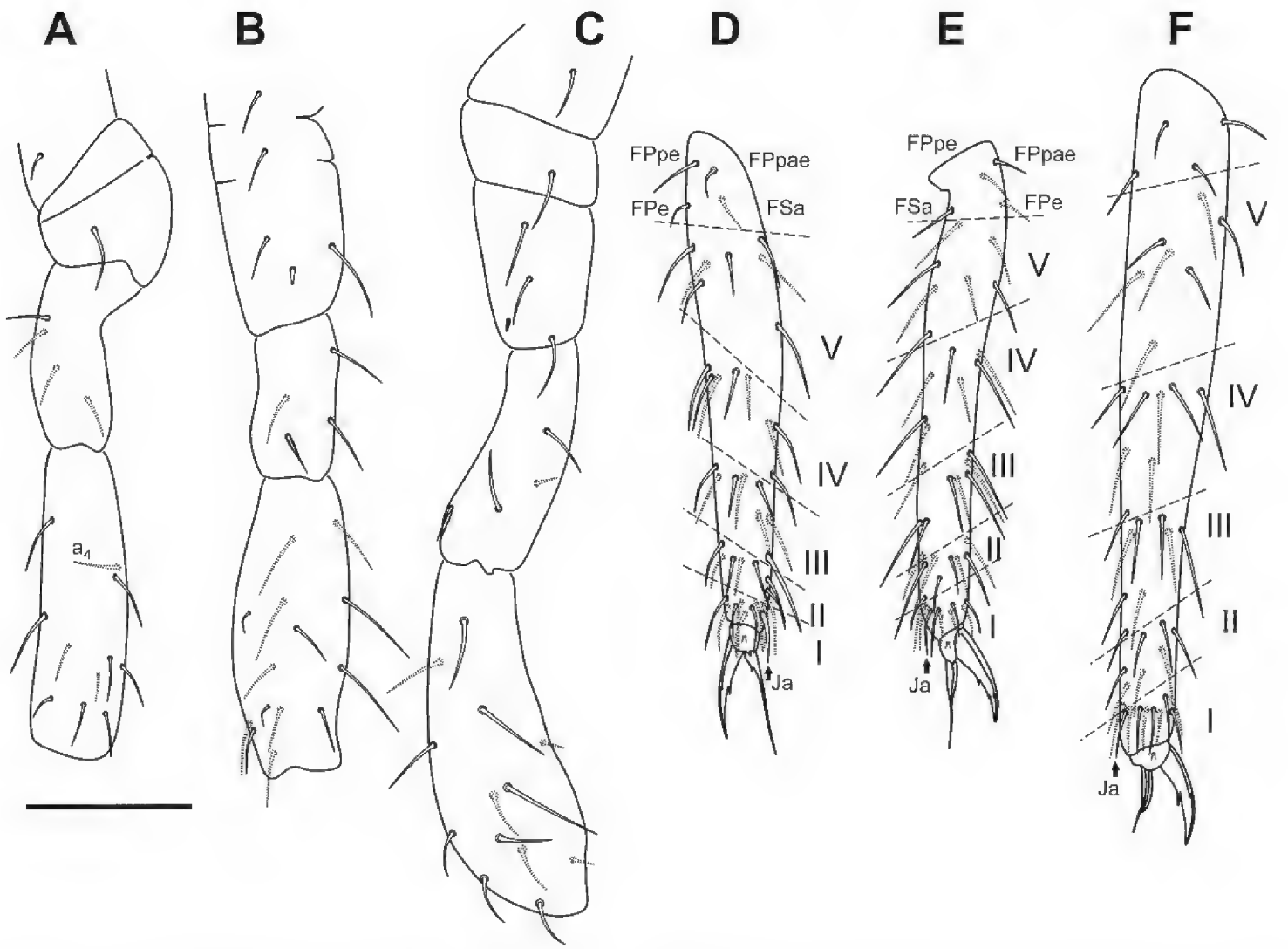

Figure 10. *Pygmarrhopalites sietae* sp. nov. **A–C** precoxa 1–2 and coxa of legs 1 to 3 respectively **D–F** tibiotarsi, claw and empodium of legs 1 to 3. Scale bar: 0.05 mm.

with 15 chaetae, two interior ones longer than others (16 because an additional one in the second whorl on one antenna of one specimen). Ant III with a conspicuous papilla, 15 chaetae, the two sense rods, and two thin setae and one short lateral sensilla; Ant IV with five distinct subsegments, with four evident whorls: one at the end of the first and three on the second to fourth subsegments. Apical subsegment with knobbed subapical organite; one of the chaetae on this area has a narrowing since the terminal half.

Legs. (Figs 10A–F, 11): Foreleg pre-coxae 1, 2, and coxa with 1, 0, 1 chaetae respectively. Trochanter with three anterior and one posterior chaetae. Femur with 11 chaetae, a_4 turned perpendicularly to the longitudinal axis of the segment. Tibiotarsus: whorl I with nine chaetae among which Ja curved and somewhat thickened, II–V with 8, 8, 8, and 7 chaetae respectively; region F with three primary FP chaetae (e, ae, pe) and secondary chaeta FSa. Pre-tarsus with one anterior and one posterior chaetae. Foot complex: claw thin, without tunica evident, with inner tooth and two pairs of indistinct lateral teeth (25 and 60% from claw basis); empodium thin, with corner tooth (Fig. 11), and long apical filament surpassing the tip of the claw. Mid leg pre-coxae 1 and 2 with 1, 1 chaetae respectively, pre-coxal process present, coxa with two chaetae and a microsensillum. Trochanter with three chaetae and a trochanteral

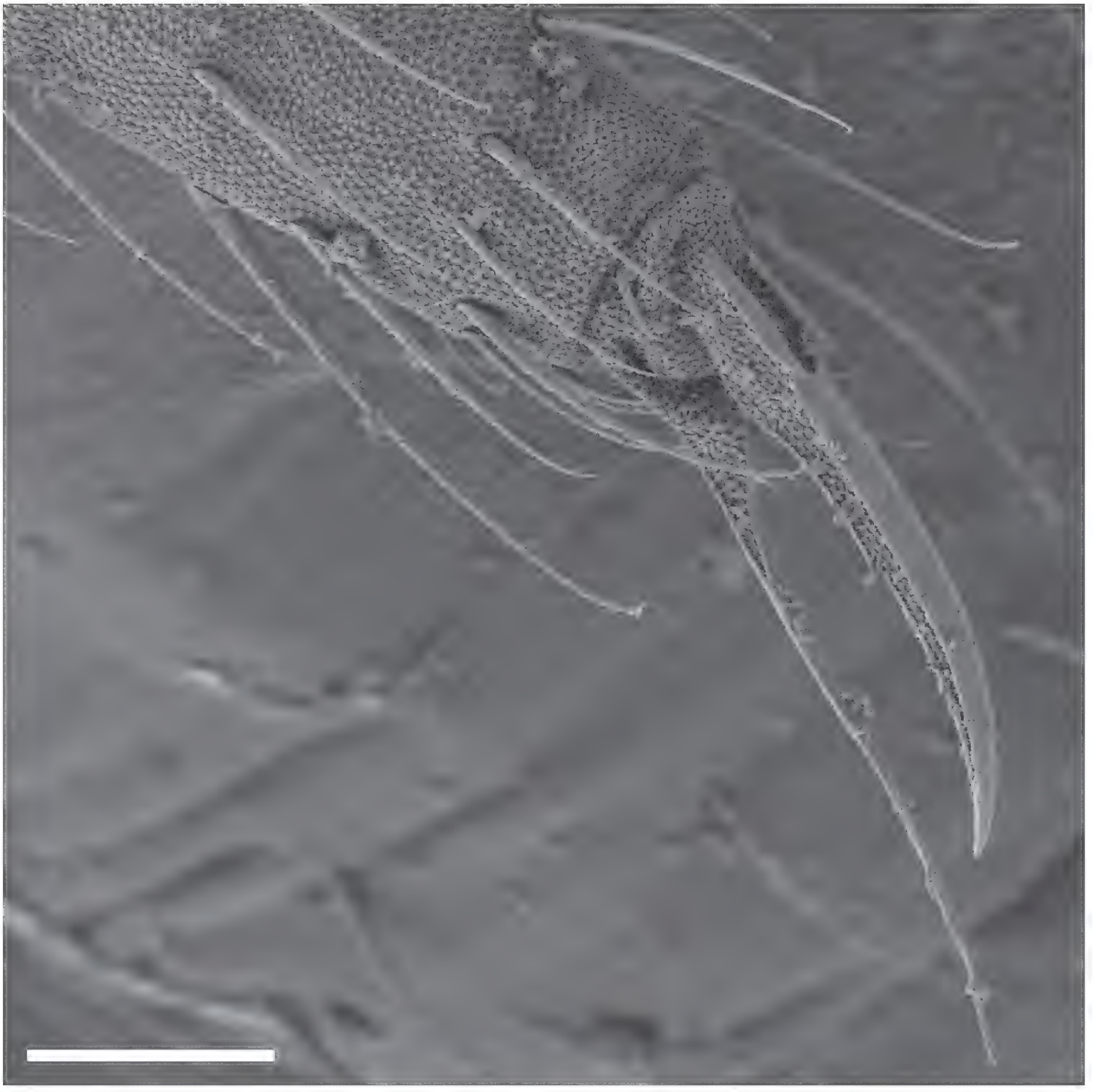

Figure 11. *Pygmarrhopalites sietae* sp. nov. Claw and empodium of leg 1. Scale bar: 0.001 mm.

organ. Femur with 14 chaetae, p_1 and p_3 very small. Tibiotarsus: whorl I with nine chaetae, whorls II–V with 8, 8, 8, and 7 chaetae respectively; region F with three FP chaetae and FSa chaeta. Foot complex: claw wider than foreleg claw, with tunica not evident, inner tooth, and two pairs of small lateral teeth; empodium without corner tooth but with a long apical filament surpassing the tip of the claw. Hind leg pre-coxae 1 and 2 with 1, 1 chaetae respectively, process on pre-coxa 1 present, coxa with three chaetae and a microsensillum. Trochanter with three chaetae and a trochanteral organ. Femur with 13 chaetae, p_1 and p_3 as mic. Tibiotarsus: whorl I with nine chaetae, whorls II–V with 8, 8, 8, and 7 chaetae respectively; region F with three FP chaetae and FSa chaeta. Foot complex: claw wider than foreleg claw, with tunica not evident,

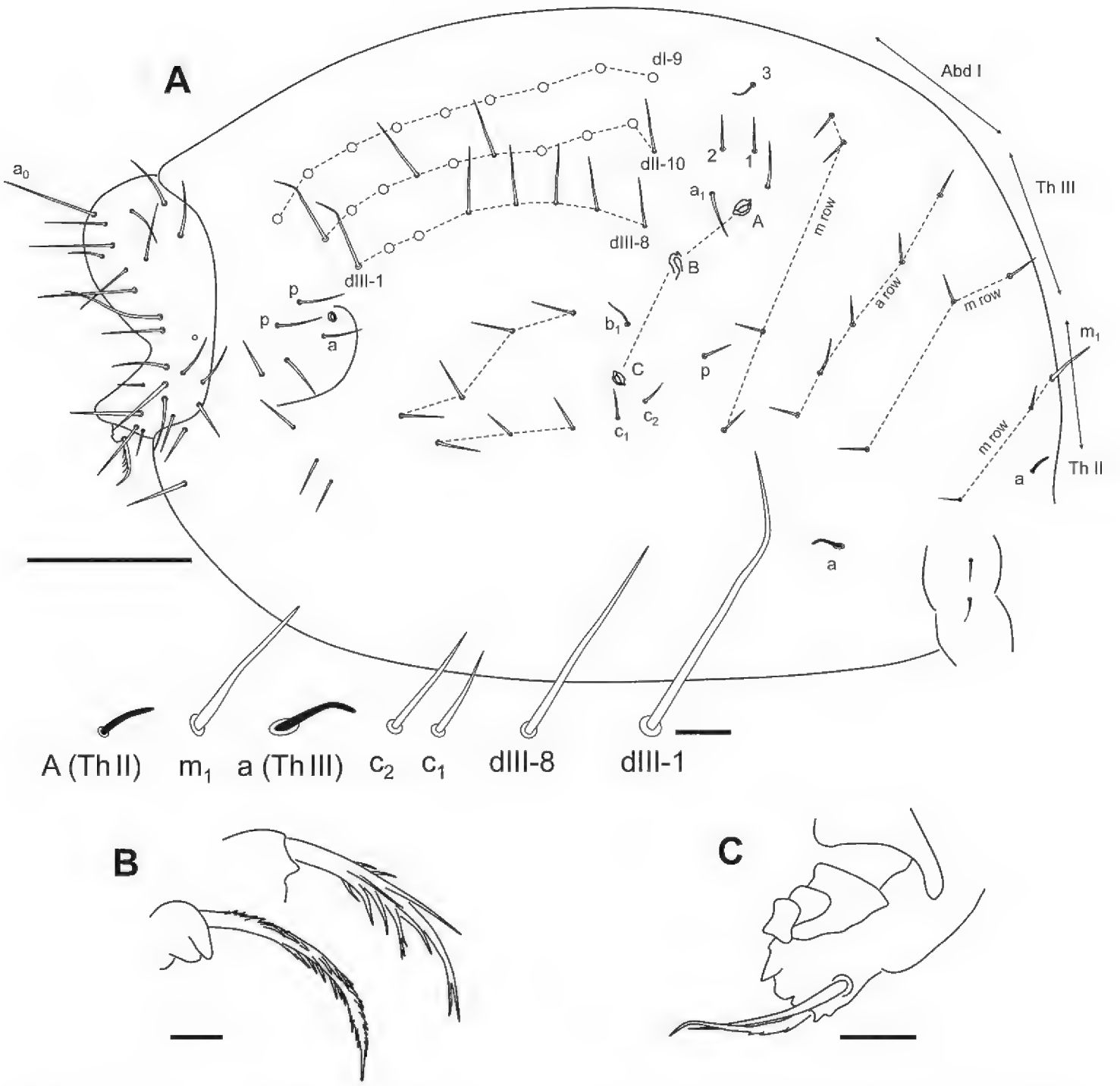

Figure 12. *Pygmarrhopalites sietae* sp. nov. **A** great abdomen, with detail of the shape of some chaetae **B** two some different morphologies of the anal appendage **C** tenaculum. Scale bars: 0.05 mm and 0.001 mm for detail of the chaetae (**A**); 0.005 mm (**B**).

inner tooth, and two pairs of small lateral teeth; empodium without tooth, and a short apical filament.

Great abdomen (Fig. 12A): Th II with a sensillum in row a, and three chaetae in row m (m_1 bigger, thickened at the base). Th III with a sensillum in row a and three chaetae in row m. Abd I row a with five chaetae, row m with four, and four p chaetae, above bothriotrichal complex. Bothriotrichal complex: ABC almost linear; bothriotrichum A with one posterior accessory short chaeta; bothriotrichum B with one posterior accessory short chaeta; bothriotrichum C with two anterior accessory short chaetae. Posterior lateral complex with 4 + 3 chaetae. Posterior dorsal complex with three rows with 8, 10, and 9 long chaetae each.

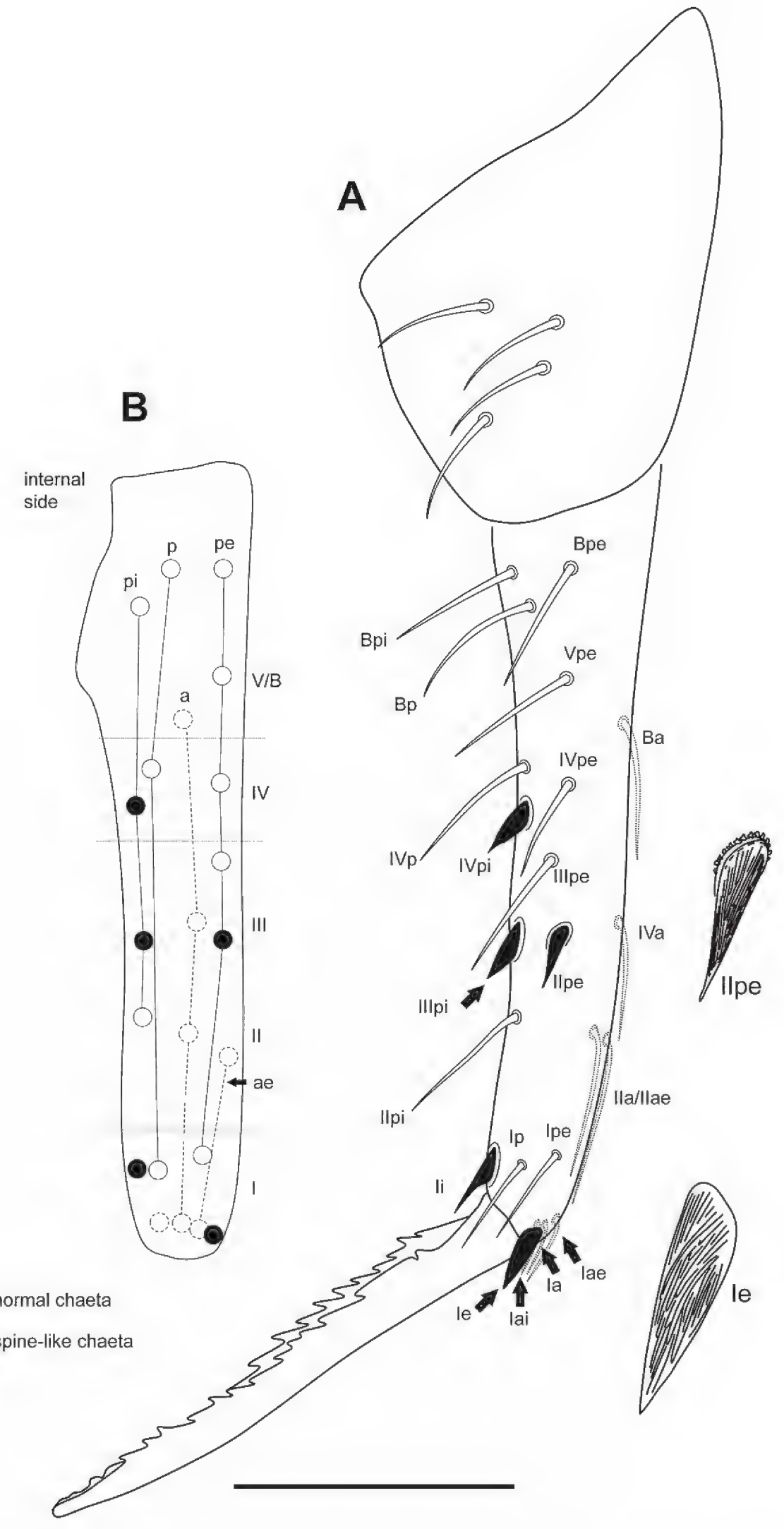

Figure 13. *Pygmarrhopalites sietae* sp. nov.: furcal complex, with detail of some spine-like chaetae. Scale bar: 0.05 mm.

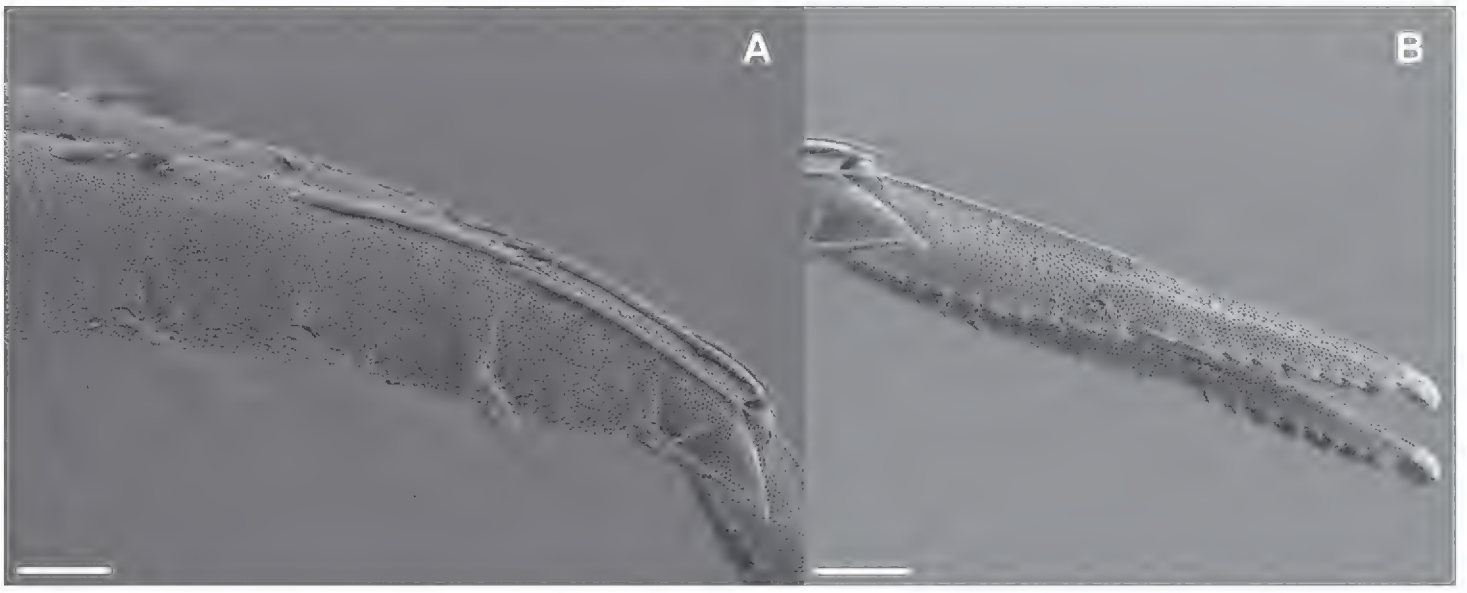

Figure 14. *Pygmarrhopalites sietae* sp. nov. **A** distal area of dentes, external view **B** mucro, external view. Scale bars: 0.001 mm.

Abd VI. Sixth abdominal segment: a_0 not bifurcate, and none of the other circum-anal chaetae broadened, winged or serrated; anal appendage with long fringes or brush-like along final two thirds (Fig. 12B).

Ventral tube with 1 + 1 subapical chaetae.

Tenaculum with two apical chaetae on the corpus, three teeth, and a basal process on each ramus (Fig. 12C). Furca (Fig. 13A, B): manubrium with 4 + 4 posterior chaetae. Dens: anterior side with 3, 2, 1, 1 chaetae; externally Ie as massive spine, and IIpe as a big spine-like chaeta; internally Ii, IIIpi and IVpi moderately spinous, but with alveoli (Fig. 14A). Mucro: both lamellae serrated forming a channel at the end. Dens about 1.4× as long as mucro (Fig. 14B).

Ecology. The specimens were only captured near the main siphon of the Maginet Room (Fig. 2).

Etymology. The name of the new species is dedicated to the association that maintains the cavity and organizes the visits, the Societat d'Investigacions Espeleològiques de Tarragona (SIET).

Remarks. There are only two previously described species that share the presence of only one eye, absence of spine-like chaetae on posterior head, presence of papilla on Ant III, the number and position of spines/spine-like on dens (203 for external/anterior/internal) and a similar shape of anal appendage: *P. furcatus* (Stach, 1945) and *P. ornatus* (Stach, 1945). *P. furcatus* has not tooth on the claw of leg 1, a long filament on empodium of leg 3, and the anal appendice simply bifurcate; *P. ornatus* has not tooth on empodium of leg 1 and the filament on empodium of leg 3 is longer than in the new species; both species have the proximal spine (IIpe) on external dens strong and articulate, while in the new species is only a spine-like chaeta. The three descriptions of *P. ornatus* (Stach 1945; Cassagnau-Debouteville 1953; Dallai 1972) do not coincide with each other; Cassagnau-Delamare and Dallai say that their specimens coincide with the original description, but in the first case the anal appendage is branched, and in the second case the circumanal chaetae are broadened (in Stach one

of the three drawings of the appendage is shown branched and the circumanal chaetae are not thickened). Bretfeld (1999) says that none of the post-Stach descriptions have consulted types (we haven't either). In future, if more specimens ar found in this cave, this species should be compared with the types of *P. ornatus*, since they are very similar.

***Arrhopalites* sp.**
Fig. 15

Material examined. One female dehydrated on stub (for SEM observation), Spain: Tarragona city, Tarragona province, Cova Urbana, geographic coordinates 41.114193, 1.248222, 15 m a.s.l. (the entrance is in an urban area), 6/vii/2022, dark zone of the cave, by aspirator (MZNA code 782956). Floren Fadrique leg (BIOSP, Associació Catalana de Biospeleologia). Specimen deposited in MZNA.

Sixth abdominal segment description: three spines per side on the dorsal valve and one on each of lateral; broadened, winged, and sometimes serrated circumanal chaetae (A_{1-3}, $Av_{1'}$, Av_1 and Av_3) (Fig. 15A, B); anal appendage with denticulation/serration at its tip, and some serrated along (Fig. 15C).

Remarks. All descriptions of the small abdomen of *A. caecus* mention 2 + 2 cuticular spines per side (two in dorsal valve and two in lateral valves) (e.g. Stach 1945; Zeppelini 2006; Fjellberg 2017) (Vargovitsh per. comm.). In our specimens, there are three spines per side on the dorsal valve and one on each of lateral (a second spine could be hidden under the broad seta in the view of Fig. 15A). Considering the spines and arrangement/shape of circumanal chaetae we consider that belongs to an undescribed species of *Arrhopalites*, but we have only one specimen and more are necessary to complete a description.

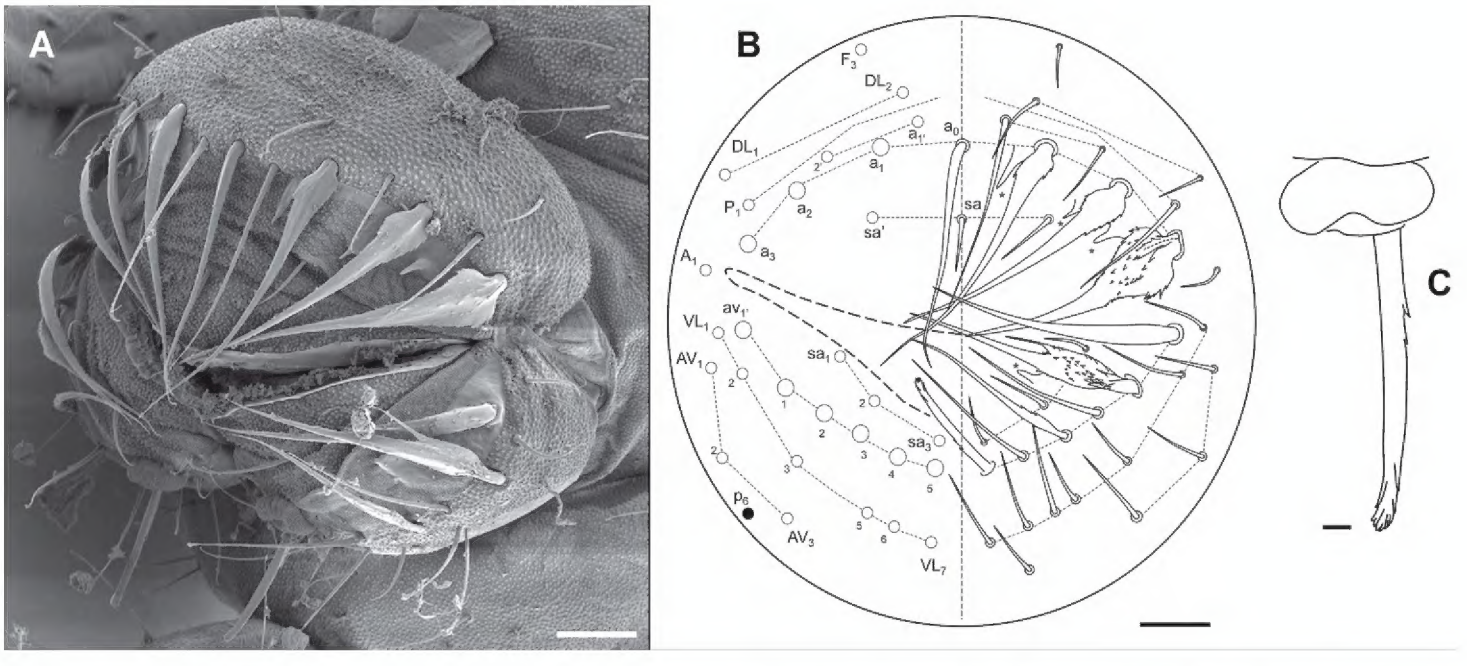

Figure 15. *Arrhopalites* sp., anal valves and circumanal chaetae **A** SEM microphotograph **B** drawing with chaetotaxy **C** detail of anal appendage. Scale bars: 0.02 mm (**A–B**); 0.003 mm (**C**).

Discussion

This work demonstrates the need for collaboration between different institutions, on this occasion two associations related to caving and natural or cultural heritage, and a university. The interdisciplinary work has made it possible to make available to those interested the topography of an interesting cave located in the center of a large city (135 000 inhabitants) belonging to the Catalonian Community, advances in the knowledge of the biocenosis of this cave, and the description of two new species for the fauna. It is once again demonstrated that the isolation of Collembola species that live in relatively close caves has caused their speciation into different species. Also that the low availability of organic matter means that the abundance of fauna in the caves is low and, as on this occasion, that human beings can be important in directing the distribution of fauna in the caves.

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